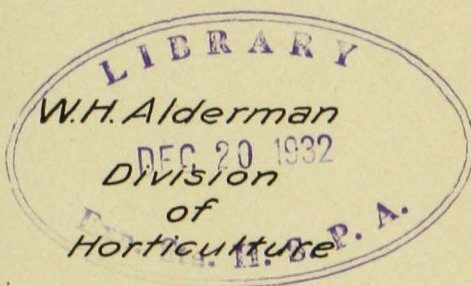


GRAFTING

and

BUD- DING



*Agricultural
Experiment
Station*

UNIVERSITY OF MINNESOTA AGRICULTURAL EXTENSION DIVISION

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THE art of grafting and budding has been known to horticulturists for more than 2,000 years and is now practiced for three general purposes. The first and most widely used purpose is in the production of nursery trees, in which case the desired variety is budded or grafted upon a seedling root. The second purpose is in topworking, whereby an undesirable variety may be worked over into one more valuable. The third purpose is in treating trees girdled by rodents or injured by disease.

The principle involved in all grafting is to bring together the growing parts of the cion and stock in order to effect a union at the point of junction. The **stock** is the plant or root on which the grafting is to be done; the **cion** is a section of the new wood from the variety it is desired to reproduce. The growing part of all woody plants (except those with large central piths and no annual rings, such as palms) is located in the inner bark, the **cambium** layer lying between the wood and the bark. In making any graft, it is necessary that the cambium layer of the stock and the cion touch in one or more places. It is also essential to exclude the air from the union to prevent the cut surface of both stock and cion from drying out and dying before a real union can take place. This is accomplished by the use of grafting wax, or similar material, which is applied thoroly over all cut surfaces of both the stock and the cion at the point where the graft is made. All grafting operations, except as otherwise noted in the following discussion, should be performed in the early spring just before the buds start into active growth.

COLLECTING CION WOOD

The cion, or part to be grafted into a tree, should be selected from a strong, healthy shoot of the last season's growth. It is best to collect these shoots during the early part of the winter and pack them away in a cool cellar in damp sawdust to prevent drying out. If they are allowed to remain on the tree until the time of grafting, they may be injured by severe winter weather or the buds may have started to swell during the first warm days of spring. It is important that the cion wood is dormant. In preparing the cions for grafting, two or three inches of the base of the shoot are usually discarded because the buds are poorly developed; the tips are not used because the wood is soft and pithy.

GRAFTING WAX AND WAXED STRING

A plastic material that may be brushed or molded about the graft union is necessary to exclude air and prevent drying of the plant tissues. Ordinary paraffin is often melted and applied with a brush. A grafting

wax of the following formula is easier to apply and is less likely to check and admit air on drying.

- 4 pounds resin
- 2 pounds beeswax
- $\frac{3}{4}$ pint raw linseed oil

Heat the materials over a slow fire until all parts are melted. Cool slightly and pour into a tub of water. With greased hands work and pull the wax until it assumes a smooth grain, when it should be molded into lumps of convenient size and stored until ready for use. This is a satisfactory wax to be warmed and applied with the hands or melted and used with a brush. The latter method is by far the more preferable. To insure a tight covering it is a good plan to apply a second coat of wax three or four days after the first.

Waxed string, used in tying root grafts and convenient for other grafts, is made by immersing a ball of No. 18 knitting cotton in melted grafting wax for about five minutes. When taken out for cooling the ball should be slowly rotated to prevent the hot wax from settling on one side. For convenience in handling, run a wire or small twig through the center of the ball.

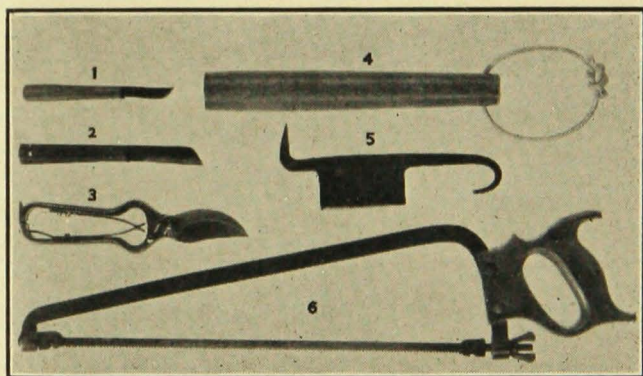


Fig. 1. Tools Used in Grafting and Budding

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|-------------------|------------------------|-----------------------|
| 1. Budding knife | 3. Hand pruning shears | 5. Grafting chisel |
| 2. Grafting knife | 4. Grafting mallet | 6. Swivel pruning saw |

GRAFTING TOOLS

Few special tools are required for successful grafting. It is essential to have the knife sharp and with a smooth cutting edge. A knife with a straight blade is preferable to one with a round point. For topworking large trees, a grafting chisel is almost a necessity. A local blacksmith can readily make one from an old file. A curved handle, as illustrated in the cut, is a convenience, enabling one to hang the tool over a limb when not in use. The mallet for driving the grafting chisel into the

stub may be readily improvised from any convenient piece of wood. A good pruning saw should be provided. Either the ordinary narrow bladed hand saw, commonly sold for pruning purposes, or the swivel blade pruning saw, is satisfactory. In no case would the pruning saw with teeth on both sides be recommended, as one is almost certain to injure the tree with the back of the saw when the cutting is done in close quarters. A good pair of hand pruning shears about nine or ten inches long is also a great convenience in grafting work and is pretty nearly a necessity to one who has any amount of pruning to do.

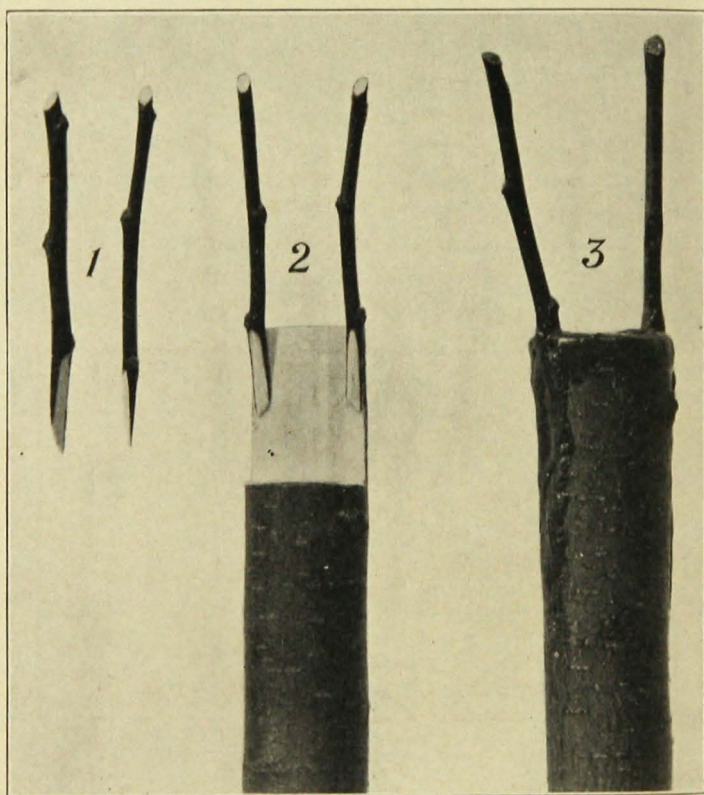


Fig. 2. Cleft Graft

1. Cions prepared for cleft graft
2. Cions in position with part of stock removed to show matching of bark on stock and cion
3. Cleft graft completed and waxed

GRAFTS

The Cleft Graft

The cleft graft is used in topworking large trees, the branches of which are an inch or more in diameter. The limbs that are to be grafted are cut off squarely with a saw at a point that is free from knots. The

stub is split downward through the center by means of a grafting chisel and then the crack held open by the wedge-shaped portion of the chisel. The cions are prepared by cutting the base in the form of a wedge, with one side narrower than the other. The wedge is then set into the cleft in the stock with the edge toward the inside and set at a slight angle so that the cambium on the outer part of the wedge crosses the cambium layer of the stock at least at one point. Unless the stock is very small, two cions are usually placed in the cleft and the area of the union is covered with wax. In addition, the tip of the cion and the open crack down the sides of the stock must be thoroly covered with wax. It is not necessary to tie or bind these cions in place, as the spring of the wood holds them firmly. In topworking large trees it is not advisable to topwork the entire tree in one year, but to extend the process over two or three years, thus removing not more than a third or a half of the entire tree-top at one time.

The Side Graft

Because of the rapidity with which it can be made and the high percentage of success attending its use, the side graft is recommended if the branches to be worked do not exceed three-fourths of an inch in diameter. A smooth place is selected upon the stock and a slanting cut made about an inch long extending nearly to the pith. A wedge-shaped cion is prepared as in the cleft graft, except that the wedge may be slightly more blunt. By bending the limb slightly the cut in the stock is opened so that the wedge of the cion may be shoved into the incision, care being taken to match the bark of the stock and the thicker side of the wedge. The natural spring of the wood will hold the cion in place without tying. The stock may be cut away just above the graft and the union covered with wax.

The Whip Graft

The whip graft may be used on small branches in topworking trees or for root grafting in nursery tree propagation. In making a whip graft, the stock is cut off just above a smooth spot free from knots. A smooth beveled cut from an inch to an inch and a half long should be made at the top of the stock. If the stock is small, this cut may extend clear across, but when a branch three-eighths of an inch or more in diameter is to be worked, it is better to make the beveled cut along one side of the stock and reaching not quite to the pith. Next, a tongue is cut, beginning about one-third of the distance from the tip of the bevel, and cutting downward about one-third of the length of the original beveled cut. Avoid starting the cut through the pith. To secure a smooth surface on the inside of the tongue, it should be cut and not split. The cion may now be similarly prepared, beginning the first beveled cut

opposite the base of a bud and making sure that the cut is approximately the same length as in the stock. After the tongue is cut in the cion, the two pieces are fitted firmly together, care being taken that the inner bark along one side is in contact. The cion should be cut about 3 or 4 inches long and should carry 3 or 4 buds. The two pieces are then bound together with ordinary cotton twine or waxed string and thoroly covered with wax about the union and on the top of the cion. After growth is well started, the string binding the two parts together should be slit along the back of the graft to prevent girdling.

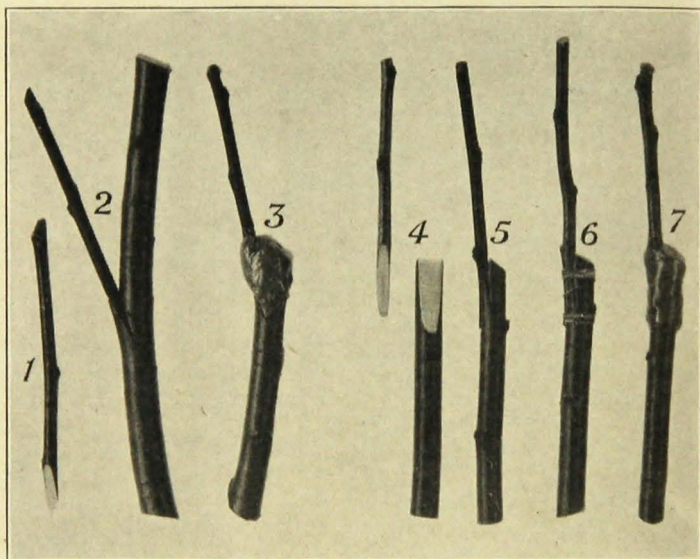


Fig. 3. Side and Whip Grafts

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|---|-------------------------------------|
| 1. Cion prepared for side graft | 5. Whip graft with parts united |
| 2. Side graft with cion inserted | 6. Whip graft tied ready for waxing |
| 3. Side graft completed and waxed | 7. Whip graft completed |
| 4. Whip grafts showing first cuts in stock and cion | |

In the propagation of nursery trees, seedling roots are cut up into about 4-inch lengths. Each piece of the root is used as a stock and a cion about 6 inches long is whip-grafted to the upper end of the root. The two are then bound together with waxed string or waxed strips of cloth. Waxing is unnecessary, as the grafts will not dry out when packed in damp material and are later planted in moist ground. The whip grafts are tied in bundles and packed away in a cool cellar in damp sand or sawdust. The grafts should be made during the winter and by the time they are taken out of the cellar for planting in the nursery, it will be found that the union and the cut surfaces at the bottom of the root will be nicely covered with a heavy callus. In planting root grafts, they should be firmly set in an upright position with the upper bud pro-

jecting above the top of ground. They may be set in rows 4 feet apart and 6 or 8 inches apart in the row.

The Bridge Graft

The bridge graft is used entirely for repairing injured trees and not for propagation. Its most frequent use is in the treatment of trees that have been girdled during the winter by mice or rabbits, or are severely affected with collar rot. It is simply a bridging over of the girdled space by means of cions that are inserted both top and bottom and which will, when united with the stock, transport food materials across the girdled area, and keep the tree alive. In making a bridge graft, the girdled surface should first be trimmed to a clean, smooth-cut edge, both top and bottom. The cion wood is selected of sufficient length to reach entirely across the girdled area. The base of the cion is cut clear across with a beveled cut about an inch and a half long. After this cut is made,

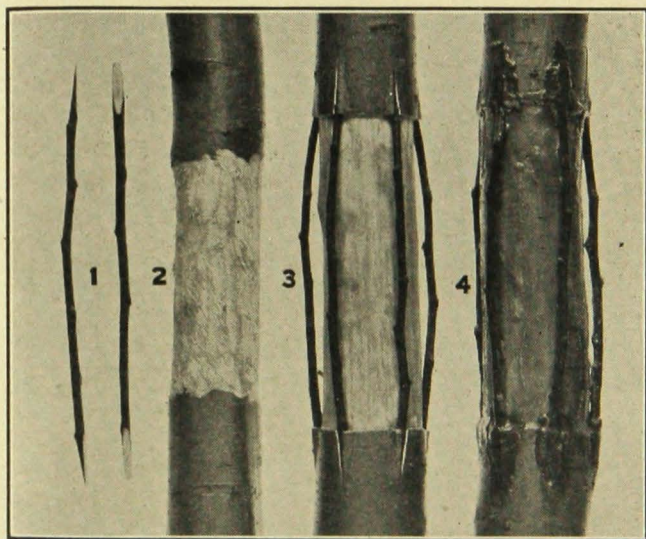


Fig. 4. Bridge Graft

1. Cions prepared for bridge grafting
2. Tree trunk girdled by rodents
3. Injury cleaned and cions in position
4. Bridge graft completed and waxed

the cion should be measured against the girdle to find its proper length and then the upper part should be beveled similarly to the bottom and on the same side. The bark above and below the girdle is then slit with a knife and the edges are loosened. The beveled base of the cion is then inserted in the slit in the bark below the girdle with the beveled cut on the inner side against the wood of the tree. It is pushed firmly downward until the entire bevel is embedded in the slit bark, and held firmly in place with one hand while with the other hand, grasping the cion

near the top, it should be bent in a bow shape until the upper bevel can be inserted into the upper slit of the bark and pushed upward into place. The now straightened cion should stand reasonably close to the trunk. Both the top and the bottom of the cion should then be tacked firmly to the tree by small slender brads. Repeat this process until the trunk of the tree is surrounded by these cions about an inch and a half apart. The point of union at both ends of the cion should be thoroly waxed and it is usually best either to wax or to paint the bare wood of the tree to keep it from drying out.

In a few years the cions will increase in size until they completely cover the girdled trunk with a shell of new actively growing wood and bark. Trees treated in this way will not suffer in the slightest degree even during the first season after grafting, provided most of the cions make a successful union.

Sometimes it is impossible to attach the lower part of the cion to the base of the tree because so much of the cambium layer has been destroyed by disease. In such cases small trees may be planted close to the trunk and grafted into the main tree above the affected tissue. The small trees are cut to the proper height, the top beveled and then slipped under the edge of the bark after which it is treated as a bridge graft. Many valuable trees have been saved in this way and the method has been found effective in saving trees injured by collar rot.

TOPWORKING

One of the main purposes to be accomplished by topworking is to change a sound healthy tree of an undesirable variety to a better variety. Another is to build a stronger and hardier tree by topworking varieties that are subject to crotch injury, such as Northwestern Greening, upon hardy strong-branched varieties, such as Hibernial.

Small trees may be topworked after their main scaffold branches have developed to a diameter of three-eighths of an inch or more. This is sometimes in the second year, but generally the third year after planting is a more favorable time for topworking. The side graft is the most satisfactory form to use, altho many use the whip graft. Set the cions into the main scaffold branches at least 12 inches from the main trunk. If a variety like Hibernial is used for stock, it will result in a tree with strong, hardy trunk and crotches resistant to winter injury at these susceptible points.

In topworking an old tree, it is generally advisable to work on branches not over 2 inches in diameter. The larger the branch, the more danger there will be of a canker disease starting in the wound before it completely heals. A cleft graft is probably the best type for this work, using two cions per limb. After about the second year, if

both cions grow, one branch should be removed. The grafting should be done in the main framework branches, going back in each case as near the center of the tree as possible without being forced to use too large a limb. As the removal of the branches in which the grafts are set constitutes a very heavy pruning in itself, all other branches should be left on the tree for the first year. This helps to prevent an overgrowth of the graft and excessive production of suckers. In very large trees it is often advisable to spread the topworking over two or more years to provide against the removal of too much wood in a single season.

BUDDING

Budding, like grafting, is used for propagating nursery plants and for topworking young trees, but the practice differs from grafting in many respects. It is performed in midsummer instead of early spring. A single bud is used instead of a cion with several buds. A freshly developed bud is inserted during the growing season and it remains dormant until the following year; in grafting, dormant cions are inserted in the stock at the close of the dormant season and come into growth the same season.

Budding is usually done in late July and early August. It can not be performed until after a bud has been formed in the angle at the base of a leaf stalk on a shoot of the current season. Budding must be completed before the active growth of the stock plant has been checked, because at that time the bark has set, preventing successful budding. In dry, hot seasons the period during which budding can be done is sometimes short. Budding on plums and roses usually begins in late July and on apples in early August.

In collecting buds for budding, select strong growing shoots on which buds are well formed and are beginning to take on a slightly mature appearance. Cut the leaves from these bud sticks immediately, leaving about one-half inch of the leaf stalk as a "handle" to the bud. These bud sticks should be wrapped in damp burlap or similar material at once to prevent drying.

The act of budding is performed by first making a T-shaped cut in the stock. The two triangular flaps of bark on either side of the upright part of the T should be slightly loosened, so the buds may easily be slipped beneath them. In preparing the bud, place the knife about one-half inch below the base of the leaf stalk and cut upward to remove a very thin slice of wood beneath the bud. The upper end or "heel" of the bud slice should be severed by a square cut. The bud may now be grasped by the handle and gently shoved beneath the bark of the T-shaped incision until the square cut heel just slips beneath the bark at the top of the T. In a modification of this method the upward cut be-

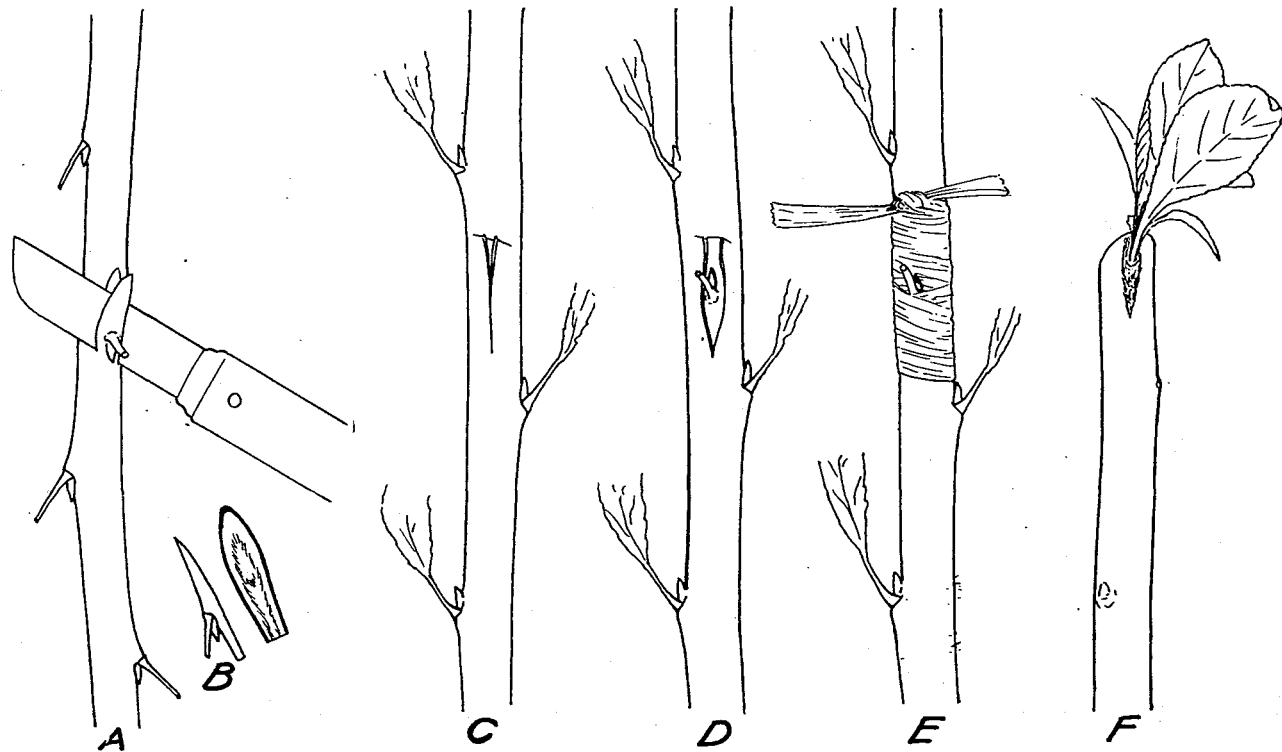


Fig. 5. Grafting

(A) Bud-stick showing method of cutting under bud. (B) Two buds removed ready for insertion in T-shaped cut in C. (D) Bud in place. (E) Bud in place and tied with raffia. (F) Stock cut away in spring and bud growing.

neath the bud is made much deeper but the cross cut at the heel is made through the bark only. The bark with bud attached may then be lifted from the wood by grasping it firmly with the thumb and forefinger on either side of the bud. This process, known as "wooding the bud," may insure a little greater success at the hands of a beginner.

Now comes an important part of the process known as "tying." Raffia that has been moistened and cut into lengths of from 12 to 15 inches is commonly used for this purpose, altho in recent years rubber bands and a cheap grade of adhesive tape, especially prepared for budding, have been used with marked success. The method of tying varies a little with the different materials but the process is fundamentally the same in all cases. A diagonal wrap is first made across the top of the T-shaped incision to hold the flap down tightly and to prevent the bud from slipping out. Then the wrap is carried to the bottom of the T-shaped cut and is wound in a firm spiral upward until the entire incision is covered with the wrap, leaving exposed only the bud and the handle. The ends of the raffia are then tied firmly. The purpose of the wrap is to hold the bark down tightly over the bud to insure a close contact of the cambium layers and to prevent air from getting in and drying the bud. These wraps should be tightly made. Lack of success by beginners in budding is generally due to too loose wrapping or to working after the bark of the stock has set. About two weeks after the bud has been set, the raffia will begin to cut into the bark if the tree is growing rapidly. At this time the tie should be cut with a sharp knife on the side opposite from the bud. When rubber bands are used, this cutting is generally unnecessary as the rubber will stretch enough to take up the growth and it will usually disintegrate through action of the weather before harm comes to the tree or bud.

After the bud has been set and the ties cut, it will need no further attention until the following spring, when the stock should be cut away just above the bud before growth starts. This will give the newly inserted bud the advantage of a terminal position on the stock from which it will make a rapid growth. It is generally necessary to go over the trees after growth starts to rub off other buds that start from the stock and which might compete too strongly with the inserted bud.

When budding in the nursery, the bud should be placed as close to the ground as it is convenient to work. In topworking young trees, branches may be worked up to one-half or five-eighths of an inch in diameter. The bark of older and larger branches is too thick and heavy for easy or successful budding.